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Further notes on *Diaphanosoma freyi* Korovchinsky, 2002 (Crustacea: Cladocera: Sididae)

Дальнейшие заметки о *Diaphanosoma freyi* Korovchinsky, 2002 (Crustacea: Cladocera: Sididae)

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КЛЮЧЕВЫЕ СЛОВА: Cladocera, Sididae, *Diaphanosoma freyi,* морфология, распространение.

ABSTRACT: The expanded description, including thoracic limbs and morphological variability, of rare North American species *Diaphanosoma freyi* Korovchinsky, 2002 has been presented. In general, this species is known from 5 localities, most of which are situated in Louisiana.

РЕЗЮМЕ: Представлено расширенное описание, включая торакальные конечности и морфологическую изменчивость, редкого североамериканского вида *Diaphanosoma freyi* Korovchinsky, 2002. В целом этот вид известен из 5 местонахождений, большинство которых находится в Луизиане.

Introduction

Diaphanosoma freyi had been described very recently from few specimens, females and males, collected in Louisiana and Missouri States (USA) and deposited in the collection of the National Museum of Natural History, Smithsonian Institution, in Washington, D. C. (NMNH) [Korovchinsky, 2002]. This material was not accessible for the dissection and preparation because most of these specimens were mounted and one of them, the holotype, was studied intact from a liquid sample.

During my second short visit to the NMNH in January – February, 2003, I had an opportunity to study more extensive material on this rare species, in particular the thoracic limbs of its specimens and population variability. All this gave the possibility to present the expanded description of the species.

Materials and methods

All the material was borrowed from samples collected by late Professor D. G. Frey (DGF) in Louisiana which are as follows:

1. Natchitoches Parish, roadside ditch on highway 1, 11 ml south of Natchitoches, 14.05.1977, 5 adult females (DGF 3856) (USNM 1022145).
2. Pointe Coupee Parish, roadside ditch on highway 190, just inside corporate limits of Livonia, 18.03.1978, 9 adult females, 3 juvenile females (DGF 4633F) (USNM 1022146).
3. Concordia Parish, swamp pond near highway 84, about 1 ml east of Frogmare, 20.03.1978, 25 adult females (DGF 4669F) (USNM 1022147).

Measurements of body parts of 16 adult females were made according to Korovchinsky [1978]. Many females from sample 3 were deformed and not suitable for body measurements. For this reason, the results of measurements of material from samples 2 and 3 were united.

Drawings, only of structures which were not presented in original description, were made by means of an RA-6 drawing apparatus.

Results

Description of females

Probably both parthenogenetic and gamogenetic females were encountered in samples because at least one of them from the sample 1 possessed a large opaque, slightly rough egg in its brood pouch. This egg was slightly oval (0.46 x 0.42 mm), as half as thick in transversal section and with a small lateral dent. The female itself had no other morphological differences from parthenogenetic ones.

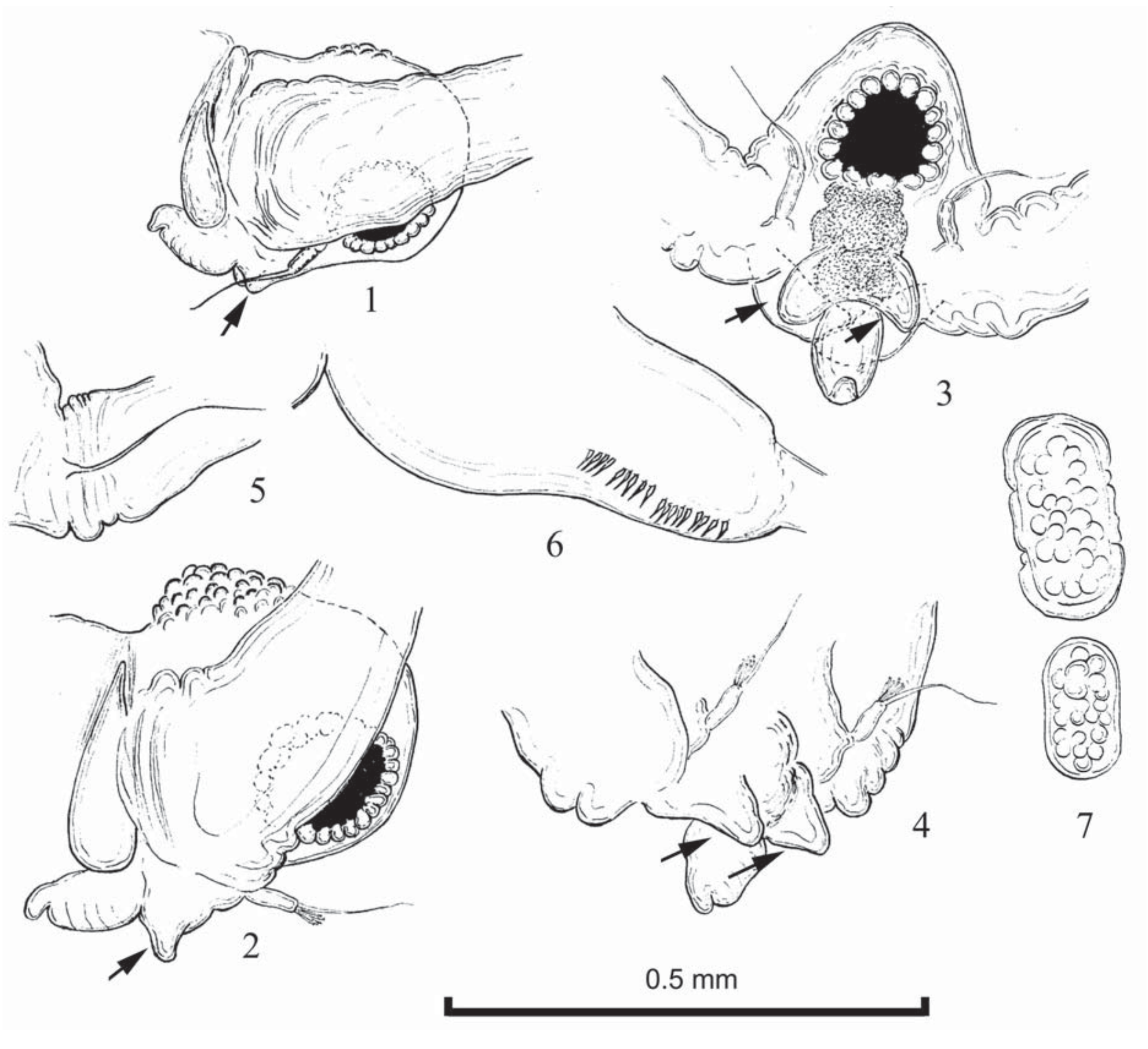
The results of body measurements are shown in Table 1.

Head massive but not large (length 30.7–37.5 % and height 19.8–25.0 % of body length), roundish-rectangular, its dorsal margin clearly sloping to the front and then smoothly or angularly joining the frontal margin. Dorsally sometimes with a group of bubble-shaped structures and a pair of rostrum -shaped prominences present on its ventral side (Figs 1–4) (the latter is also seen in holotype (see Fig. 1 in Korovchinsky, 2002)). Eye comparative large (10.0–13.0 % of body length). Antennules small with comparatively short sensory seta. Swimming antennae longer than in type specimen (67.9–74.7 % of body length), sometimes reaching and sometimes not reaching the posterior valve margins. Long seta on dorsal side of basipodital basal part (Fig. 5). Large sharp spine on the basipodite's distal outer end. Proximal segment of two-segmented antennal branch (exopodite) with large sharp spine.

Table 1. The measurements of body parts of adult females of *Diaphanosoma freyi* (in each column from top to down: limits, mean, SD, CV).

Таблица 1. Измерения частей тела взрослых самок *Diaphanosoma freyi* (в каждой колонке сверху вниз: пределы вариации, средняя, среднее квадратичное отклонение, коэффициент вариации).

Body length, mm	Head length : Body length, %	Head height : Body length, %	Diameter of eye: Body length, %	Length of swimming antennae: Body length, %	Length of setae natatoriae: Body length, %	Length of antennal exopodite: Length of basipodite, %	Length of antennal endopodite: Length of basipodite, %
0.75–1.44	30.7–37.5	19.8–25.0	10.0–13.0	67.9–74.7	64.8–83.8	83.7–106.0	55.6–75.5
1.10	33.5	22.6	11.4	70.8	74.5	96.8	67.7
	2.0	1.8	0.82	2.0	5.5	7.7	6.5
	6.0	7.9	7.2	2.9	7.4	7.7	9.6



Figs 1–7. *Diaphanosoma freyi*, females (DGF 4633F, besides fig. 7 from DGF 4669F): 1, 2 — head, lateral; 3 — head, ventral; 4 — rostral area of head; 5 — dorsal side of basal part of basipodite; 6 — postabdomen, lateral; 7 — cells of Microsporidia (?) in body cavity.

Рис. 1–7. *Diaphanosoma freyi*, самки (DGF 4633F, кроме рис.7 по DGF 4669F): 1, 2 — голова с боковой стороны; 3 — голова с вентральной стороны; 4 — ростральная область головы; 5 — дорсальная сторона базальной части базиподита; 6 — постабдомен с боковой стороны; 7 — клетки Microsporidia (?) в полости тела.

Similar long spine with one outer and one inner small outgrowth near its base on the end of the exopodite distal segment. Three-segmented antennal branch (endopodite) with a long spine on the end of the second segment. Antennal setae 4–8 / 0–1–4. Armament of antennal setae as usual for genus: setules of the longest apical setae of both branches differentiated into thick proximal ones (row type) and thin distal ones (sensitive type); all other setae uniformly possess only thick setules [Korovchinsky, 1987]. Ventral valve margins form a fold which seems moderately wide and connects smoothly with the postero-ventral margin. The fold bears 14–16 long feathered setae, the proximal ones on its inner side with five to seven setules between each them. Six to 14, mostly nine to 12, comparatively small denticles along postero-ventral valve margin with three to six tiny denticles and 1 setule between each of them (the latter ones may be sometimes poorly visible). On the valves of the same specimens the number of these denticles usually differs (7/8, 8/11, 10/12, 11/13, etc.). Posterior valve margin more or less wavy and armed by some setules and groups of small denticles. Groups of two to four inner thorn-like spiny setae near the posterior-dorsal junction of valves which number also often differs on valves of one specimen (2/3, 4/3).

Maxillules (mx I) with five feathered setae and one modified seta denticulated distally, posteriorly of them the maxilles (mx II), formed as small outgrowths with maxillary duct inside (Fig. 8). The armament of the thoracic limbs is shown in Table 2, where *n* indicates number of endopodital (of each endite) and gnatobasic filtering setae, 1, 2, etc. — number of apical and lateral soft exopodital and endopodital setae, *I* and *i* — modified setae of distal gnatobasic corner (Fig. 16),*p*. — small seta on proximal gnatobasic corner (Fig. 15) (see also Korovchinsky, 1991, 1995 for comparison).

Numbers of exopodital setae of thoracic limb I are indicated on its distal and lateral part respectively (Table 2). One short soft seta on the end of 4th endite above the row of filtering setae (Fig. 11), six short gnatobasic setae bent to the mouth and 7th one backwards together with modified corner seta (*I*) (Fig. 9). In thoracic limbs VI *i* indicates small prominence between 2nd and 3rd proximal setae of endopodite (Fig. 17).

Postabdomen with groups of small anal teeth on its lateral side, sometimes numerous (Fig. 6), and some groups of tiny spinules all over its length. Setae natatoriae long (64.8–83.8 % of body length). Terminal claws long and massive with three long, thin basal spines of almost equal size, two distal of which are characteristically crossed. Body length 0.75–1.44 mm. Smaller specimens (0.68–0.70 mm) are probably juveniles because they have incomplete number of setae on the antennal exopodite (4 + 7).

Body cavity of some specimens from sample 4669F was filled by numerous cells of unknown nature (Fig. 7), possibly of Microsporidia (Protozoa).

Variability

As seen from Table 1, the general morphological variability is rather high. It is of special interest, that length of antennal exopodite may be slightly shorter or longer than that of basipodite which is comparatively short.

The number of specimens was too low to make detailed interpopulation comparisons but it is possible to note that specimens from sample 3856 had a small number of denticles on the postero-ventral valve margins (6–8) and more numerous spiny setae near the posterior-dorsal junction of valves (often 4) than those from other populations (e.g. specimens from sample 4633F always had by 3 setae here).

Discussion

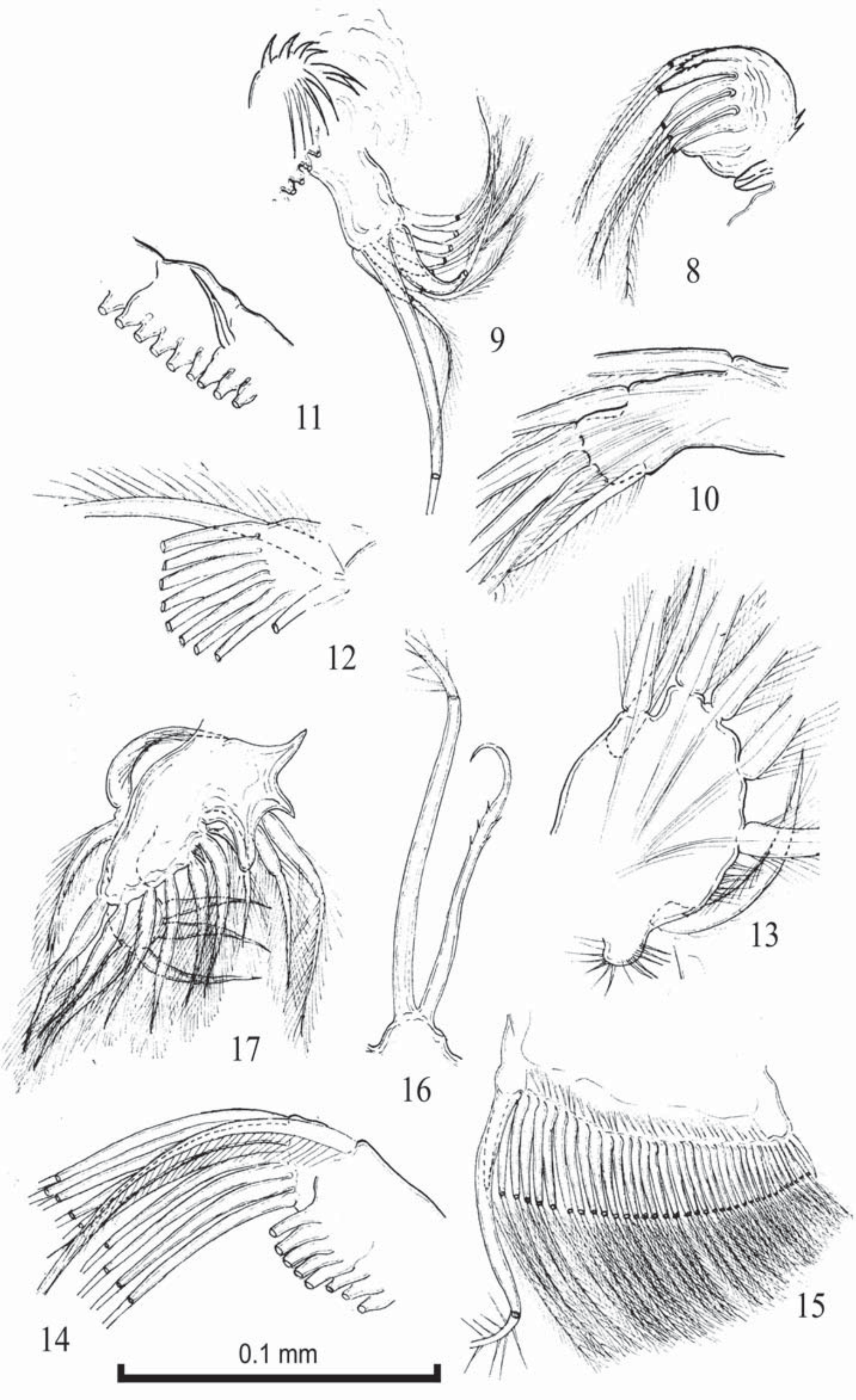
D. freyi, which adult females reach 1.44 mm in body length and on average more than 1.0 mm, is one of the large species of the genus such as *D. unguiculatum, D. mongolianum, D. dubium.* It has an unique morphological structure, the rostrum – shaped prominences, which has not been found in other species of the genus. These prominences remind those of *Penilia avirostris* Dana, 1849 and may be of atavistic nature indicating an origin of the genus from the ancestor with well-developed rostrum. The bubble-shaped structures on the head's dorsum may be derived from the dorsal organ of juveniles, their function remains to be unclear. Swimming antennae of the species with comparatively short basipodite and long two-segmented exopodite are characteristic of littoral species with reduced swimming ability [Korovchinsky, 1995].

In spite of general morphological specificity of *D. freyi,* its thoracic limbs only have two specific traits: especially large number of filtering setae on the endopodite and gnatobase of thoracic limbs of pairs II–V (44–65 and 33–36 respectively), which even exceeds that of largest species of the genus, *D. senegal* (31–51 and 26–34 respectively) [Korovchinsky, 1991], and the presence of two *vs*. one lateral setae on the exopodite of pair VI. The former trait may characterize *D. freyi* as an especially fine filterer.

Data of this study also confirm that *D. freyi* has gamogenetic reproduction in spring and early summer because female with resting egg (see above) was observed in May as well as males in April and June [Korovchinsky, 2002]. This coincides with the general reproduction pattern of cladoceran species in the south-

Table 2. Armament of thoracic limbs (indications see in the text).
Таблица 2. Вооружение торакальных конечностей (обозначения см. в тексте).

Limbs	Exopodite	Endopodite	Gnatobase
I	5 + 5	(n8 + 1) + (n5) + (n5) + (n47 + 1)	n7 + I + i
II	6 + 5	(n10 + 1) + (n5 + 1) + (n5) + (n42)	n36 + I + p
III	6 + 5	(n9 + 1) + (n5 +1) + (n5) + (n41)	n36 + I + i + p
IV	6 + 5	(n8 + 1) + (n5 + 1) + (n4) + (n37)	n33 + I + i + p
V	5 + 4	(n5-7 + 1) + (n37 + 1)	n33 + I + i + p
VI	4 + 2	7 + i	2 + 3 outgrowths



Figs 8–17. *Diaphanosoma freyi,* females, details of thoracic limbs (DGF 4669F): 8 — maxillula and maxilla; First pair: 9 — gnatobase; 10 — end of exopodite; 11 — seta above the row of filtering setae of endopodite; 12 — end of endopodite; Second pair: 13 — end of exopodite; 14 — end of endopodite; 15 — gnatobase; Third pair: 16 — modified setae on distal corner of gnatobase; 17 — thoracic limb of sixth pair.

Рис. 8–17. *Diaphanosoma freyi,* самки, детали торакальных конечностей (DGF 4669F): 8 — максиллула и максилла; Первая пара: 9 — гнатобаза; 10 — конец экзоподита; 11 — щетинка над рядом фильтрующих щетинок эндоподита; 12 — конец эндоподита; Вторая пара: 13 — конец экзоподита; 14 — конец эндоподита; 15 — гнатобаза; Третья пара: 16 — модифицированные щетинки на дистальном углу гнатобазы; 17 — торакальная конечность шестой пары.

ern United States having gamogenesis before the dry season [Frey, 1982].

In all three localities *D. freyi* was found in small and temporary water bodies (swamp pond, roadside ditches) which together with previous data [Korovchinsky, 2002] confirms its attachment to such habitats.

D. freyi appears to be mostly known in Louisiana (four localities of five). Most of localities (four) are situated in the direct vicinity of the Mississippi River.

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